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WHAT YOU ALWAYS WANTED TO KNOW ABOUT
MONITORING NAVAL SHIP CONSTRUCTION
BUT YOU DID NOT DARE ASK

by

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June 1990

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What You Always Wanted to Know About
Monitoring Naval Ship Construction
But You Did Not Dare Ask

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ABSTRACT

Control of a Naval Construction project, is a significant and difficult problem; Project complexity, and contract type, military urgency, and contractor identity affect the degree and type of control necessary. This thesis study discusses a summary of essential guidance for performance of functions; the interdependency of cost, quality, time, and performance; and a survey of techniques and methods for managing each of these parameters. A naval construction project can be one of the most difficult problems to manage and evaluate. This is largely due to the difficulty of measuring performance and its interaction with cost, quality, and time. In managing the performance, the results will vary according to the different forms, such as contract administration, formal views, financial and engineering reports, quality assurance and various status indexes.

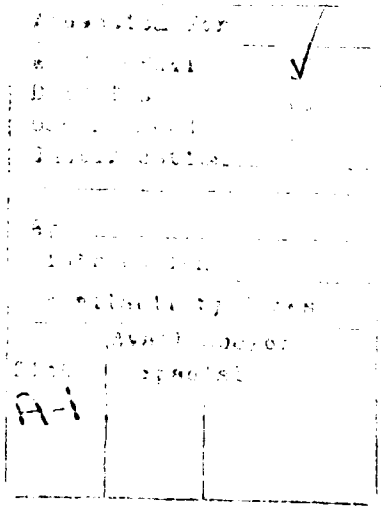

TABLE OF CONTENTS

I. INTRODUCTION

We have to examine the concept of the Naval Construction Project Management (NCPM) from the view of a higher level management, specifically that of the responsible person -- the Project Manager. The Project Manager has to solve a complex problem, which is influenced by many technical disciplines, specialized jobs, and coordination of skills.

A serious issue is the problem of assuring that a sufficient pool of skilled professional personnel are ready, willing and able to perform the Project Management of these projects. The availability of this pool lies at the heart of the Department of Defense's (DOD) ability to successfully administer projects.

The Project Manager is expected to complete the project on time and within the budget, while meeting technical and performance requirements, and keep contact for further logistic support. Due to the complexity of the job, the Project Manager and his assistants are promotable, seasoned senior officers. The job is parallel to the command of a major combatant.

The Management Information System (MIS) is affected by the collection and/or reporting of accurate information and:

- monitors the contractor's cost and payments
- ensures the accuracy of the contractor's control,
- compares the actual cost to budget criteria, and
- reports the progress through standardized guidelines and an inspection system.

It is essential to manage the progress, cost and quality of a naval construction project in order to ensure the successful completion of the project task regardless of the internal or external environment of the project. This thesis examines several means of monitoring the progress from a large variety of methods and techniques that have been used by Project Managers.

II. PROBLEM DEFINITION

A. PURPOSE

This thesis analyzes the mission of a Naval Construction Project Manager (NCPM) from the viewpoint of the Navy, i.e., the client. This is because the Navy or the Government (which provides the funds) requires the construction to be completed according to the estimated cost, to have a high level of quality, and to be finished on schedule.

The Navy or the Government, as a large organization, has an active role during the construction. It is necessary to realize, however, that not all contractors are alike. In particular, some well-organized contractors are professionals and have their own way of handling a contract, and other contractors, lacking in organization or for other reasons, are unable to complete the contract.

The actual Project Manager and his team are called upon to follow up the terms of the contract; make proper decisions on engineering changes and modifications; negotiate any cost change; reduce time and cost as much as possible; increase the level of the accepted quality (in comparison to the prescribed quality); and after the completion of the construction, make the acceptance easy, timely and successful, and accurately evaluate the results for future improvement.

B. SCOPE

The scope of this thesis is to review and evaluate the existing background of the NCPM, examining all the relative material of official procedure, theory, literature, and software.

Each Project Manager is expected to solve the complex problem of the Naval Ship Construction, comprising several different overlapping factors, each of which has a different effect on:

- estimated cost,
- prescribed completion time,
- minimum accepted quality level,
- limited sources, and
- big variety of working personnel.

In contrast to overhaul in construction, there is not as yet a ship's crew. In overhaul projects, the ship's crew, which is familiar with the material and generally cares for the ship, can help with the work and make the Project Manager's job much easier.

C. CONCEPTUAL DESIGN

For the conceptual design of the management efforts, we quote the Principles of Management, as they were presented by Fayol (Ref. 1:p. 35).

- Division of Labor (Manpower)
- Authority
- Discipline
- Unity of Command
- Unity of Direction
- Subordination of Individual Interest to the Common Good
- Enumeration
- Centralization
- The Hierarchy
- Order
- Equity
- Stability of Staff
- Initiative
- Esprit de Corps

D. CONTROLLING PROJECT MANAGEMENT

The role of the Project Manager and his team is to insure that Naval Construction will meet the given targets by utilizing the available resources. By controlling the system, we want to ensure that resources are obtained and used in an effective and efficient manner, accomplishing also the organization's objectives.

The project control is intended to monitor the following three key issues:

1. The process involves managers working with various managerial tools.

2. The control process takes place within the context of objectives, policies, and contractual arrangements that have been determined within the strategic planning process.

3. Optimal control provides for efficiency and effectiveness with minimal intervention. Several of the distortions of natural economic forces are a result of the environment in which DOD must acquire a Naval Ship. Frequently there exists only a sole source supplier for a sophisticated platform. Often the tactical situation dictates an extreme urgency for an acquisition to be completed. Thus, a portion of this environment may be so inflexible that it naturally resists control; and in fact, the Navy has seldom been willing to penalize or prosecute non-compliant contractors.

For most large programs, the Navy feels compelled to continue with the initial contractor no matter how inefficiently resources are utilized. As a result of such policies, many contractors become lax in maintaining adequate control. For the same reasons, major contracts are seldom cancelled and holding contractors to the original contract specifications is not generally considered a realistic alternative.

The degree of control that a Project Manager must exercise over the contractor will theoretically vary with the type of

contractual arrangement. Depending on the type of contract, a program that involves a low risk product, will require marginal control only. The underlying implication in such cases is that the contractor accepts the risk and management responsibility.

As the risk of a project is escalated, or specification changes are negotiated, the managerial responsibility shifts more and more to the Navy with subsequently more control being exercised from outside the shipyard. The underlying truth is that the Program Managers need to maintain some form of control over their program regardless of the type of contract that is negotiated. The advantages of using the Project Management are to:

1. meet the targets of contract,
2. reduce costs, if possible,
3. decrease construction time, and
4. insure the quality and performance of the material.

Normally, Project Management faces some unusual problems in trying to direct and harmonize similar forces in a project situation. In examining the primary difficulties, it is observed that they are centralized to organizational uncertainties, unusual decision pressure, vulnerability and top management errors. Any lack of control may cause one or more of the following problems:

- Increase of total cost
- Expansion of completion time
- Reducuction in quality level
- Have an operating cost that exceeds the benefit for the Government

Finally, we can say that the quality of the job of the Project Management team depends on the quality characteristics of each individual and much more to that of Project Manager. Hard working, good officers with integrity, intelligence, flexibility, adequate skills and training are called for; related experience is welcome (not necessary).

There are several ways to control performance of a contract of Naval Shipbuilding. The following is a list of relative problems that may inhibit adequate measurement:

1. One of the least understood areas is that of control over technical performance. Control of technical performance is a critical aspect, and many techniques could be exercised to effectively provide this control.

2. Another performance control is that of contract specification. Here performance control is obtained through a number of techniques. Application of any individual technique depends upon the nature of the project; the lifespan, the level of risk, the size, and the criticality of the project. But the simplest and most common tool for performance control is contract incentive fees.

3. The third type of performance control is through formal reviews. This technique involves performance control on a service or DOD formal reviews. It represents an increase in control involvement over a firm fixed price contract.It also requires the Project Manager to examine project effectiveness and percent of performance objectives that have been accomplished. These formal reviews require that the manager gain knowledge of his program's status and recommend corrective action if necessary.

4. Performance control through engineering reports, is similar to the above first mentioned technical performance, but this control contains quality assurance of the engineering efforts. Performance monitoring works on an inevitably frequent basis and required information, which must be obtained through reports.

The last way of controlling utilizes additional techniques. These techniques examine the results of various performance tests that generally are meaningless to any other parameter of cost and time. The assumption is that performance merely relates to some simple functions of cost and time.

Thus, we can produce a system in any given time if we can alter the performance and funding restraints. A critical aspect of the Project Manager's job is to determine these "performance/cost/time" relationships and be able to decide when a given trade-off is no longer cost effective.

E. RESEARCH QUESTIONS

The primary questions that could be posed are:

1. What is the real mission of the Project Manager and how much flexibility should he be authorized in his job?
2. What is the best procedure to select the Project Manager and his team in order to succeed?
3. What should a Project Manager know and how can he prepare himself and his team to succeed?
4. How should the construction be accomplished?
5. How should a Project Manager perform the functions of decision-making efficiently?

Some of the secondary questions that can be asked are:

1. What is the theoretical background of Project Management?
2. How much could computers be used in construction? What are the available computer software packages for Project Management?
3. What are the current scientific trends?
4. What is the current international bibliography?
5. How many and which specific reports are necessary and how could they provide service documents?
6. Can we attempt to provide advance guidance for accomplishment of the service-unique function?

F. METHODOLOGY

The style of approaching each concept will be simple and all the relative factors will be contained in paragraphs and sub-paragraphs. The methodology that is followed in this thesis is:

1. Defined terms, distinguished from other related terms.
2. Prescription of the current requirements of any construction.
3. Examination of all prospective of the Project Man-agement issues and the need for professional skills.
4. Presentation of existing important theoretical background and techniques.
5. Analysis of existing material.
6. Projection of results and recommendations.

G. SYSTEM REQUIREMENTS (RESPONSIBILITY)

A Project Manager manages the combined efforts of the contract in support of project development to confirm upon termination that the project is going to meet the established

cost, schedule and performance requirements. The general approach to these responsibilities is to:

1. Define the goals of the project and strive to prepare a project plan for accomplishing these goals.
2. Formulate engineering and support cost estimates to accomplish the goals of the master plan.
3. Prepare schedules for the complete project and establish a system to review, control, report, and evaluate the project status.
4. Negotiate with other organizations within the Government for research, design, test, and other services, if necessary.
5. Determine what phases of the project will be performed by contractors, subcontractors, and participate in the review of bids, contractor's proposals, contract specifications, etc.
6. Participate in design reviews, contract negotiations, and technical and business discussions with the contractor.
7. Review and appraise the effectiveness of the contractor in meeting the technical and administrative requirements of the contract.
8. Monitor project reviews and readjust funds, schedule, and work for accomplishing the project.
9. Resolve any problems or conflicts that impede progress, insuring that the contractor works effectively toward timely completion of project.

H. ANALYSIS OF EXTERNAL INTERFACES

The selection of Project Manager is important. The Project Manager reports and receives directions from either the Program Executive Officer or the Service Acquisition Executive. A selection should take place at a reasonable time before the start of the project. After the selection, the

Project Manager is stationed at the shipyard, and writes the program charter from the Mission Need Statement.

He then follows the establishment of the Program Office, staffed with the Project Team, who have been selected under the same criteria and procedure as the Project Manager.

Milestone I and the "Concept Exploration and Definition Phase" starts with the preparation of the Acquisition Strategy, within 90 days of reaching Milestone 0.

The second action is to organize in draft a program with enough flexibility to produce innovative and more effective solutions for project cost, schedule, operational effectiveness, suitability of goals, and thresholds. Later, the use of an MIS to register all the required information for the derivation of life cycle cost. The last action is the approval of the above preparation phase.

I. INPUT/OUTPUT

We must consider how we should access the necessary information into a storage system, and what types of reports we are obliged to produce. Input is, without a doubt, the most important area of this job. Without precise, accurate, and timely data, we cannot be adequately informed. The accuracy of information is based on a combination of a good method of data gathering, and on good data.

Although it would seem an easy matter to insure that good data enter the system, there are several reasons why it may

not. An extensive education program is essential before the start of the construction program to alleviate the fears of workers and managers. It is also necessary to locate the responsibility for accuracy of data close to the source of the information.

The introduction and use of a Management Information System is an indicated solution as it uses, in addition, some specific and compatible software packages, which are described in the following chapters. The most widespread and least expensive method of collecting data, is through a personal computer monitor, which is connected on-line with a local network computer system.

The type and extent of inputs to the system will depend primarily on the amount and type of information that is to go into the system, and on the amount we are willing to invest. There are a lot of different types of reports that could be generated, depending upon their capabilities. The following four are basic:

1. Exception reports identify problems, delays, or unexpected developments in the schedule of some process.
2. Predictive reports give the alternatives generated by our predictive models. These are the reports which are used to aid the decisions about the future.
3. Schedule listings comprise the bulk of all the generated reports of the MIS. They include many routine progress reports, stock levels, schedules, and price/cost reports, which are seemingly necessary to run an efficient organization. The types and numbers of these reports are only bounded by the imagination and needs of Project Management.

4. Demand reports are the most difficult and costly reports to produce. These are usually real-time outputs on a terminal which respond to one-time query from Project Management. Since they are quite varied, they are hard to format, and therefore, expensive. Predictive reports, another variation, may be a type of demand reports.

The type and extent of any inputs and outputs to MIS are going to depend on the price which the Project Management team or the Shipyard is willing to pay for each capability, weighted against the necessity to have that capability available. It is within the technical competence of system analysts and programmers to develop an MIS, which could meet all of those areas discussed above.

III. ENVIRONMENT

A. DEFINITIONS

Project. A project is a complete cycle of activities and functions that leads to a specific goal or a predefined target. The project implements a part of a program and is usually a prototype, oriented to the specific job or need, with limited relations to other projects.

Control. Control is an element of the management process which includes planning, organizing, staffing and directing. Control can also determine if the objectives of the contract requirements are being matched to the program plan [Ref. 2: p. 27].

Management. Management is "the art of getting things done through people. Also Management is the process of planning, organizing, leading and controlling the efforts of organization members and of using all other organizational resources to achieve organizational goals" [Ref. 3:pp. 3-4].

Management Control. Management Control is "the process by which management assures that the organization carries out its strategies, effectively and efficiently, in the accomplishment of the organization's objectives" [Ref. 4:p. 3].

The three key ideas in this definition are intended to convey the following:

- The process involves managers working with various managerial tools.
- The control process takes place within the context of objectives, policies, and contractual arrangements that have been determined within the strategic planning process.
- The control must be exercised in order to provide for efficiency and effectiveness as close to optimal conduct as possible.

1. Project Management

Project Management is a complete and systematic method of planning, monitoring and controlling an assigned task to provide the best possible output for the least expenditure of time and resources. Project Management is closely linked to productivity and exploitation of each skill at the Project Manager's command. Inherent in this system are the functions of the following:

- organizing and operating,
- scheduling and planning,
- controlling and staffing, and
- feedback and evaluation.

2. Naval Construction Project Management

Naval Construction Project Management (NCPM) is a complete system that improves all the activities and functions after assigning the building of a Naval Ship Construction through the delivery and the final acceptance. During this time the procuring agency of the Navy needs to link with the contractor. These linkages should be defined clearly, be well documented and supported to ensure cost effectiveness, timeliness and quality.

B. ENVIRONMENT

The external environment is the Defense Logistics Agency (DLA), the goals of which include the following articles:

1. Contract Administration is done within the Defense Contract Management Command (DCMC), mainly on site, by

the Defense Contract Management Regions (DCMR's), the Defense Contract Management Area Operations (DCMAO's), and Defense Contract Management Plant Representative Offices (DPRO). They have a full time commitment to the project, while DCMR are mostly staff function oriented, and may work on several projects at the same time.

2. Plant Security ensures that contractors are appropriately securing classified information.

3. Quality Assurance and Control, for the inspection of material and services under the Military Specifications (MIL-Spec).

The following inputs are associated with the multiple-functioned NCPM:

1. Personnel (Staff, project team, contractor, etc).

2. Methods and processes.

3. Time barrier data.

4. Financial and budgeting.

To emphasize the necessity of Project Management, consider the following biblical example:

> The Babylonions started building the tower of Babylon with great desire, but failed to finish because of a lack of communication.

C. ORGANIZATION

The type of organization that should be established depends on the type of contract.

The most widely used type of organization is the pure contract. This describes the independent status project that has enough budgeted funds and working personnel for the

specified project [Ref. 5:p. 51] under the control of the Project Manager.

The second type is the functional organization that is the most relevant organizational structure, based upon the hierarchical structure. This was originally founded on managerial theories, such as specialization, line and staff relations, authority responsibility, and span of control. The weaknesses of functional organizations' lack of motivation and inertia, along with difficulty in setting priorities when multiple projects are involved. These kinds of structures are engineering oriented and often fail to meet the goals [Ref. 6:p. 259].

The third type is the project organization, which is the opposite of the hierarchical and functional organizations. It is a single-purpose structure project, or a vertical organization, and it is a multi-dimensional structure within a broader multi-dimensional organization.

The last type is the matrix organization. Here we have a different perspective in a multidimensional structure that tries to maximize the strengths and minimize the weaknesses of the types above. It is a combined vertical hierarchical structure with a superimposed lateral or horizontal structure of a project coordinator. The major advantage is that it uses the facilities of the organization. The major disadvantage for the Project Manager is that he has limited control over his people.

In very large projects, the Project Manager has to deal with:

- the complete responsibility for the temporary organization he heads,
- the reporting relationship to displace the functions of the whole organization,
- the required unique disciplined executive effort, and
- the regular division that is relevant to any other division of the whole organization. [Ref. 7:p. 325].

Some other characteristics of the personnel are:

- that they are located at the consolidated area,
- that they are familiar with the way the organization works, as they are people of the Government, or the consumer and,
- that the project team has a finite and specified lifetime.

The Project Manager acts as an executive, reporting periodically to his superioars (through the appropriate staff members). The frequency of editing reports depends on the needs, the ability to produce automatic reports and the gravity of the project. The organization of personnel of the Naval Ship Construction project is usually along the pure project type functional lines.

The criteria for selecting the best type is not easy. No one particular approach is perfect for all situations. The current trend is to edit a list of the key-factors, depending upon the existing experience and the current circumstances. Before the final choice is made, the following three additional factors should also be considered:

1. The relationship between the organizational design, the skills of Project Manager and his staff, and the project planning and reporting system.

2. The ways of coordination and commitment in the functional structure, without moving to another structure, like project or matrix organization.

3. The variations that exist in the matrix structure and what the strengths are.

D. LINK TO PROGRAM MANAGEMENT

The terms project and program are synonymous and often tend to be confuseed with each other. They have interchangeable meaning depending on the other used related terms. Project has a very broad meaning. For our purposes, project means a unit of work involving constructive thought and action in connection with goal-oriented efforts.

The term project is also applied to the study, development, mission, or operation of related complex systems. It has a clear orientation associated with some related factors according to the performance of effort, the value or cost, and time limitations. Usually in government, environment projects are subsets or part of programs that are considered as completed tasks. Every Project Management contains some particular characteristics:

1. typically unique nonrecurring undertakings,
2. important character and a sense of urgency,
3. special precise requirements,

4. consideration of performance, cost and schedule, and
5. clear objectives and goals.

E. CONTRACT INFORMATION AND SYSTEM REQUIREMENTS

Several major problems may exist when monitoring performance. They include the following:

1. Firm Fixed Price (FFP) contracts generally do not reveal a performance degradation until the product is delivered. We can say that the contract is reactive rather than predictive. In the case of sole source, the problem of resolving a defaulted contract may be particularly difficult to achieve. The Navy has shown a great reluctance to penalize contractors who default on contract specifications.
2. Cost Plus Incentive Fee (CPIF) contracts have a tendency for the contractor to maximize long-run vice short-run profits. Incentives seldom get to people who carry out the project on a day-to-day basis.

A large profit from the incentive program may be regarded as an indication of a deceptive original proposal and large windfall profits. This may stimulate Congressional or Navy investigations as well as jeopardize future negotiations. [Ref. 8:p. 240]

Performance guaranteed by terms of contract may be effective, or merely be an exercise in paperwork. Perhaps the problem with the cost plus incentive-fee contract is not the underlying logic of the economic forces, but rather the effectiveness with which we integrate the contract with other managerial skills and tools.

F. CONFIGURATION MANAGEMENT

The mission of Configuration Management is to describe the current configuration, by utilizing a detailed plan. This plan includes all the necessary information of the current situation and the progress done in construction. The Configuration Manager works directly for the Project Manager. He is responsible to identify and keep track of the current configuration of the Ship construction. The major functions are:

- Identification is the first step within the configuration plan, perceiving the personnel involved, applying the organization's policy, make the applicable changes, as well as producing reports and reviews.
- Control keeps records of engineering changes of proposals, and identifies procedures to be followed. Military Standard (MTL-STD) 480A/481, deals with configuration control, containing the required reports and procedures during business.
- Status Accounting obligates contractors to maintain an MTS for recording the engineering change proposals, and be able to briefly explain each situation.
- Audit schedules the induced audits by asserting the configuration plan.

G. ENGINEERING MANAGEMENT

A System Engineering Management plan is usually written by the contractor, in order to complete the contract requirements and keep informed of the current progress of business. The relative concepts involved are presented in the following paragraph:

- Conducting the scientific and engineering aspects of the system to achieve the stated objectives.

- Confirming that the system performs to specifications, as well as feeding back the need for redesign the specifications.

- Examining the contract data requirements and maintaining current the technical data that define operational base lines.

- Perceiving and ensuring compatibility, and data intra-system and ship-system interfaces throughout the system's life cycle.

- Developing maintenance concepts and criteria for all levels of maintenance, including the efforts on publishing technical manuals, preventing and corrective maintenance.

- Reviewing the technical manuals and blueprints for completeness and adequacy.

- Feeding the Integrated Logistic Support planning and implementation.

- Sponsoring engineering change proposals to increase the system performance in accordance with mission requirements.

- Evaluating the impact and comparing the resulting cost, performance, schedule and all their relative concepts, like productivity, system interface, effectiveness, reliability, maintainability and logistic support.

- Developing and estimating requirements of the applied techniques and methods, procedures, equipment and facilities to assess system configuration.

H. PLANNING/SCHEDULING/TIME CONTROL/FULL SCALE DEVELOPMENT

The results of the various activities in planning and scheduling are summarized in a project plan. Such a plan is useful as a reference guide, helping all the parties involved and the Project Manager. The main elements of a project plan are listed below: [Ref. 9:p. 89]

- Goals and objectives
- System requirements
- Organizational structures (internal/external)
- Contract requirements and targets
- Contractors-subcontractors
- Milestones and task bar charts
- Overall project schedules
- Software for flowcharts
- Allocation of resources
- Engineering
- Editing reports and routine procedures
- Cost control and payments
- Evaluation

I. BUDGETING/PAYMENTS

A Naval ship is considered to be a one-hundred percent finished when all construction has been complete. In addition, correction of all defects and deficiencies must be accomplished in accordance with the contractual requirements. The percentage values of completion is determined by combining in a predetermined ration the total percentage of labor progress and material progress that are separately considered.

This percentage of completion also determines the progress payments due to the contractor on the basis of specified percentage values assigned to various elements of the required work in connection with the progress status report.

All payments of the contractor are divided in three categories depending the type of contract:

1. Fixed Price

These contracts include the following payment clauses:

a. Under the SECNAVINST 7810.12a clause

This clause provides payments that are based on physical progress, where payments are made at 100% during the second half of performance. The two performance retained reserves are:

- Two percent of the contract price is withheld. This could be increased if it appears that the reserve is insufficient to complete unfinished work.
- Payments may not exceed 100% of the costs incurred during the first half of contract performance and 105% of the costs incurred during the second half of contract performance.

b. Under the Federal Acquisition Regulation (FAR) 52.232-16 clause

This clause provides for payments based on the cost incurred up to a maximum of 80% for the other-than-small business or 85% for small business. The ACO may decrease or suspend progress payments under the circumstances listed herein. These progress payments are based on recorded costs (actual payments plus incurred costs) that must be paid to be considered in the base for progress payments.

c. Under the NAVSEA vessel progress payments clause

Under this clause, payments are based on physical progress, made at 90% of the progress achieved during the first half of performance and 100 during the second half of

performance. It also contributes that payments may not exceed a percentage ceiling (less than 100% of costs). Escalation Payments are subject to the limitation. In some other contracts, escalation payments clauses are within the ceiling payment in excess of contractual limitation that defers until contract completion.

d. Under Cost-Reimbursement type contracts

In these contracts provisional payments of allowable costs incurred and portions of a fee are made during the contract performance, retaining the percentage of payment according to the contract terms. The cognizant makes payments against contractor invoices or public vouchers submitted once a month to the cognizant contract auditor. A final payment of the allowable costs and of the fee is conditional on final settlement by the contractor.

J. INTEGRATED LOGISTICS SUPPORT

Integrated Logistics Support consists of the following:

1. Integrated Logistics Support Management Team (ILMST)

The team supports the ILS manager who is usually a permanent member of the Project Management Team.

2. Integrated Logistics Support Plan (ILSP)

This plan implements in detail all the functions and operating facets of acquisition.

3. Logistics Support Analysis (LSA)

a. Types of LSA

- Repair level analysis registers all the subcomponents in repairable categories.

- Reliability Centered Analysis settles the preventive maintenance cycles (weekly, monthly quarterly, semiannually, annually, etc.). The frequency of maintenance is determined from relative formulas that are based upon existing experience.

- Maintenance Task Analysis calculates the skilled personnel needed (number, level, specialization) to support the prescribed maintenance.

- Survivability Analysis calculates and predicts the wartime requirement of support, introducing some corrective actions.

b. ILS Issues

- Maintenance of Main Plan. A long-term schedule containing the installed and portable equipment. It also contains the requirements of personnel, frequency, level of effort, suggested time, etc.

- Manpower and Personnel. Almost half of life cycle costs constitute Manpower and Personnel data that indicate the numbers and skill level requirements for the supportability of the Manpower Estimate Report.

- Technical Data. A systematic documentation of all technical information related to construction, financial data, publications, drawings, etc.

- Support and Test Equipment. A list of required checkouts, calibration, maintenance, and operation equipment for support aboard and ashore. Support contains scheduled and unscheduled maintenance actions.

- Supply Support. A list of all the general consumable and outfitting materials, spares and tools required for an autonomous supportability of each unit.

- Facilities. Predetermined requirements of assets for the full support of the system throughout the life-cycle period.

- Packing, Handling, Storage and Transportation. Requirements for the complete support of the material.

- Computer Hardware. Supports the material for the life cycle period relating to hardware, software, manpower, training, documentation, etc.

- Training Support. Ensures the best utilization of the material. It includes both the initial training for Navy familiarization and operation of the system as well as the replenishment training to cover attrition or personnel replacement.

- Design Interface. A relationship between logistics design parameters to readiness and support resources requirements.

- Technical Data. Operating and maintenance information required for the adequate and functional support.

4. The Characteristics and Role of the Project Manager

The role of the Project Manager is not easy to describe as it is multi-functional, an relates to a lot of different jobs. It includes cooperation and communication with people from different parties working for, sometimes, opposing goals. The more complex the job, the more important it is to examine what each Project Manager brings to the job.

The Project Manager usually "exercises full line authority and responsibility over all planned direction and control of tasks (defined as the minimum or threshold requirements for effective performance) [Ref. 10:p. 42] and resources in developing, testing, producing, fielding, and supporting a weapon system". [Ref. 11:p. 38]

A typical Project Manager is not "an expert" in every aspect of procurement. The Project Manager should have sufficient competencies (including motives, traits,

aptitudes), and knowledge or skills, so that he could manage trade-off and avoid "snow jobs." Making a job analysis or a systematic approach to the characteristics of the Project Manager, results in finding that his activities are focused toward tasks and competencies.

The Defense Studies Management College, studying the qualification of the competencies of Program Managers, selected a competency-based approach to jobs that was developed from ideas of Charles River Consulting of Boston, Mass. [Ref. 12:p. 42]. It examines the role of the Proj :. Manager utilizing the following five-step approach:

- Meet with a resource advisory panel.
- Select the candidates to be interviewed.
- Conduct in-depth interviews.
- Develop the competency model.
- Validate the competency model.

A Project Manager must have the ability to escape from daily routine traps. It is important for him to know when to involve himself, in order to solve problems of his subordinates (that need detailed or skilled guidance to achieve the primary objectives).

The Project Manager is the primary person responsible for the successful termination of the project, but portions of his responsibilities are transferred to the people of the project team. Thus, everyone is responsible for the

unpredictable evolution of his own career. This assignment could be a promotional or detrimental event of that career.

Another important consideration is time. The Project Manager should have sufficient obligated service time in order to cover the total project milestone pericd.

The variety of characteristics that a Project Manager should have depends on the problems that he is called upon to solve.

- Rank of Officer is 05 or 06 or equivalent.
- Attend a 20-week Program Management course.
- Must not have declined any previously designated command (if he is selected as a principal).
- At least four remaining years in service.
- Should be engaged in a development program or possess a research development specialty.
- Must have adequate experience in some significant areas (Research and development, logistics, comptrollership, procurement, automatic data processing, communications and electronics, operations research or systems analysis).
- Be a graduate of a senior service college and have a baccalaureate degree in engineering or other physical science. Additionally, an advanced degree in business, procurement, management operations research and systems analysis, engineering or physical science is required.

The eligible Project Manager must be considered and must be chosen by both the NMPC board and the annual command boards. The board then evaluates the qualification selecting the principal and three alternatives [Ref. 13:p. 38].

IV. THEORETICAL ANALYSIS

1. INFORMATION IN GENERAL

Every Project manager has to deal with a great deal of information. Ideally, information should be provided clearly, completely, accurately, and sent to the right person the first time. Increasing the amount of information used will correspondingly increase the sphere of influence, but will also lead to information bottlenecks and operating errors.

A good manager acts so as to avoid the above drawbacks and develops a system to manage the organization. The elements of MIS differ according to various authors, but the most essential are the following:

- The computer-based information is drawn from a comprehensive data base.
- Ability to provide near real-time reports.
- Enables to retrieve information from the past, as well as present, in a readable and understandable format.
- Uses the existing information to make future projections.
- Has significant information-gathering capabilities.
- Ability to build a data-base system in a relatively simple and updated manner.
- Ability to supply relevant information and demand.

The primary objective is to provide timely information and aid in the allocation of the resources and in the selection

of alternatives. A good MIS also focuses on providing information to decision makers in both the tactical and strategic levels.

1. Cost

Even though data information is often free, there is a cost for searching, typing, storing, sending, retrieving, reforming and manipulating information. Utilizing information results in several costs, the most important of which are following:

- Organizational cost
- Purchase of hardware and network/communication apparatus
- Purchase of Software
- Education and training
- Operational and maintenance activities
- Costs to retrieve, reform, and maintain the results

2. Benefits

Having sufficient information strengthens the position of the Project Manager. He can use the existing information and compare the current situation to others, as well as prevent future problems.

3. Education

Education increases the abilities and effectiveness of the Project Manager and his staff. When properly implemented, education provides a significant contribution to the effective accomplishment of their mission within the Navy. Education

improves the qualification of all personnel at all levels, and provides the foundation for a continued and coherent program.

It is important to outline the skills, level, and quality of knowledge and abilities in Project Management, necessary for competent performance. This applies to the training plan that must be applicable to all levels of personnel. This plan must also address movement and advancement of employees from junior positions, through journeymen to senior levels. Both formal and on-the-job training is at the heart of career development within a comprehensive Project Management Training Program. Training is needed in order to achieve a high level of management proficiency for all the project's activities.

The education program will cover all pertinent areas of Project Management, not only that of the Project Manager and his staff, but also, **depending on the functional area**, for all working personnel.

B. PROJECT MANAGEMENT THEORY

The need for the Project Management started when large and traditional organizations had to deal with temporary projects. A more organized, dynamic, flexible, and effective management was required that was based primarily on a vertical flow of authority and responsibility.

The concept of Project Management is defined as "a special management approach used to centralize authority and responsibility (on a team or task force basis) for the

priority accomplishments of a specified project or task. The task critical to the organization's success involves the timely integration of divergent specialties and activities into coherent, coordinated management" [Ref. 14:p.29]. The organizational structure usually has a limited span of control and this structure becomes the basis for the chain-of-command. This kind of disadvantage can best be reduced by means of a structured program organization diagram. This diagram must be realistic and clearly contribute to all the intended organizational relationships.

As the Project Management has limited resources within the Navy, it provides modest permanent staffing, suggesting support and administrative assistance from functional groups.

The five basic principles of management theory are: Planning, Organizing, Staffing, Directing, and Controlling. These principles will be briefly presented in combination with the military acquisition system.

1. Principles

a. Planning

Planning is "the selection from among alternatives of future courses of action for the organization as a whole and each department within it" [Ref. 15:p. 81]. The main steps used to integrate planning are:

- Determine objectives and goals.
- Settle premises.

- Define and evaluate alternatives.
- Conceive derivative plans.

b. Organization

Organization is "the grouping of activities necessary to accomplish goals and plans, the assignment of these activities to appropriate departments, and the provisions for authority delegation and coordination" [Ref. 16:p. 227]. Every organization contains the following functions which have a direct relation to the production objectives and the economic environment of the job:

- Business Management.
- Productivity.
- Systems Engineering.
- Performance and Quality Assurance.

c. Staffing

Staffing is "the executive function, which involves the recruitment, selection, compensating, training, and retirement of subordinate managers" [Ref. 17:p. 442]. The staffing process involves several steps that all-together explain the successful way to achieve:

- Development
- Job definition
- Appraisal
- Promotion

d. Directing

Directing is "the process by which actual performance of subordinates is guided toward common goals" [Ref. 18:p. 535]. The directing principles contains each of the following factors:

- Guidance
- Supervision
- Motivation
- Communication spans

e. Controlling

Controlling is "the measurement and correction of the performance of subordinates in order to make sure business objectives and the plans devised to attain them are accomplished" [Ref. 19:p. 639]. The controlling process has three basic steps:

- Establishment of Standards
- Measurement of performance
- Corrections of Deviations

2. Divisions

Every well organized project is divided by the phases that simplify and ensure an effective monitoring. The following is a list of those phases:

a. Conceptual Phase

This is the starting phase; the basic idea is conceived and a preliminary evaluation follows. There are also

examinations and evaluations, that determine the environment and forecast possible schedule changes, program objectives and alternatives. A first scan for estimation of cost, time, and performance will clear the view of the project. Preliminary strategies, organization and requirements of resources will then be established.

b. Definition Phase

A more detailed and positive approach of cost, time and performance will determine the future of the project, as well as the way they fit together. During this phase, the reevaluation and reaffirmation of the objectives must be completed before committing to acquisition and construction activities.

c. Construction and Acquisition Phase

The primary phase, during which the objectives of constructing the Naval Ship begins and ends. During construction procedures and standards produced during the preceding periods are implemented. It also contains activities in procurement, ordering of materials, construction of facilities, training of personnel, as well as allocation of authority and responsibility.

d. Operational Phase

After the completion of the construction, test procedures will prove the conformance of the produced Naval Ship according to the objectives of the contract. The contract contains comparisons in the economical, feasible, and

practicable attainment of the organization goals, as well as evaluations for the efforts of the preceding phases. Finally, the completed and operational Naval Construction is delivered for service.

e. Divestment Phase

During this phase the responsibility of the project is transferred to the supporting organization after successful delivery. Then extended evaluation activities will provide information for future improvements. Lessons learned and a final report will terminate the chain of Project Management.

C. USEFUL MONITORING AND CONTROL METHODS/TECHNIQUES

Monitoring a project means to accomplish some variances during the construction period. This is can be done by using an analog project estimation (where we compare the new project with a similar old one) and a parametric method of looking at several old similar projects (it uses some relative estimating relationships).

In managing the quality processed, it is not enough to merely identify the problem saying that the objective of the control effort is to solve that problem. A Project Manager goes further and defines in precise terms how the control effort accomplishes its objectives and how far it should extend its scope. The sophistication and complexity of the control system is determined both by the nature of the project and by the ability of the participants to administer it.

A simple project may require only a few control techniques to determine if cost, time, and schedule parameters are being met. A Naval construction as a major project requires sophisticated and extensive control techniques. Regardless of the magnitude of the project, certain prerequisites must exist in order to have a workable control system.

In order to present the various types of the existing methods and techniques used, it is necessary to describe several essential parameters of control systems. First, the control system must be clearly understood by those who use it, along with the interfaces and scopes of the control system. This clarity of understanding and use may significantly affect the accuracy of inputs, standards, and analysis. Second, the control system should be predictive in nature. The control system must anticipate deviations and indicate the nature of the problem, as well as report program deviations on a timely basis. This will ensure that corrective action can be taken before serious problems arise. Finally, the control system must be economically efficient. The additional cost for the operation of the control system must not exceed the possible savings.

In the last thirty years, several techniques have been used for the convenience of the Project Manager. The control of project performance has become the critical measure of success. Numerous techniques are utilized and effectively

provide this major control. Some of these techniques are well known. A list of the most commonly used techniques are presented in the following paragraphs:

1. GANTT Charts

This method is named after the inventor, Henry Lawrence Gantt, and was designed to help manage shipbuilding during World War I. This was also the first time that a scientific method was used to compare the actual performance to the original plan. The GANTT charts are simple bar charts which represent each task as horizontal shaded bars, drawn to a common time scale. Simultaneous tasks appear as bars stacked on top of one another. The various events could be sorted by date, and flow from the top left to the lower right.

2. Critical Path Method

Critical Path Method (CPM) was developed in 1957 via a joint venture by Dupont Company and Remington Rand Univac. The objective was to determine a method of upgrading the requirements to perform a routine overhaul, maintenance or construction plant. The efforts contained issues of reducing the duration and total cost of the project. It also applies to functional activities as it contains planning, scheduling and controlling roles. This method uses an operational network that relates all activities in a time dimension, separating the critical from subcritical activities.

3. Program Evaluation and Review Technique (PERT)

PERT was developed or the U.S. Navy Polaris Project at the same time CPM was developed for DuPont. It is a very similar tool, with the main difference being that PERT takes the stochastic duration of activities into account, while CPM assumes deterministic durations.

4. PERT/COST

This technique is used in conjunction with the PERT network system discussed above and provides the Project Manager with essential schedule and cost conformation, and a framework for the integration of technical performance.

Network and work breakdown structure are the basic tools employed in the development of a PERT/COST system. The network is primarily used for planning and controlling of schedules while the work breakdown structure is used for the planning and control of cost. These techniques offer the Project Manager the following:

- The current project plan, schedule and budget.
- Time and cost performance to date, in relation to plan.
- Time and cost projections for the completion of the project objectives.
- A ranking of problem areas by criticality.
- An indication of potential trouble spots.
- Anticipated schedule slippage, and cost overruns or underruns.
- A means of determining where management can withdraw resources to assist more critical phases.

5. Line of Balance (LoB)

This technique is oriented towards controlling progress and schedule accuracy through balancing of the resources, and measuring the amount of the completed items, rather than the time of completion.

This also relates the actual status of the elements of a production program to planned progress, identifying the particular elements that are lagging due to delay in the delivery of the end item. Advantages of LoB are the abilities to assemble, interpret and present the essential actual elements and factors that are involved in the production process. The four primary elements are the following:

- The objective of the planned and actual delivery schedule.
- The program of the production plan. The program process of the current performance status.
- The composition of the program, to the process.

6. Budget and Cost

As the actual progress and planned progress are compared, actual costs and planned expenditures must also be compared to enable the Project Manager to detect deviations and take corrective action to prevent further cost overruns.

The budget is the starting point of all control techniques. It should be organized in a manner that will enhance the ability to monitor actual costs against planned expenditures. The budget should also be split at the low level work structure.

A dilemma the Project Manager usually faces in funds management is cost control versus funds control. This ensures that the expenditure ratio is not going faster or slower than budgeted. It is essential that the budget be prepared to use time frames. These time frames should be as short as possible, and be compatible with the time frames associated with cost collection data. The questions that Project Managers should consider:

- Are periodically-available funds of the five-year defense plan during the next few months going to meet the work schedule?
- Are funds allocated at the budgeted area by time-schedule payments?
- Is cost of construction of the Naval Ship higher or lower than the budget?
- Do alternatives exist to handle any unpredictable deviations (by additional funds or making major reductions in the size of the program)?

7. Status Index

This method is an analytical and interpretive tool that is easily used to fulfill the Project Manager's needs for cost progress correlation. The status index is used to form a completion forecast through trend line analysis, after enough data points have been obtained.

The status index is a means of integrating actual progress and costs within the project plan, that provides the Project Manager with:

- Time-Cost performance of every date, in relation to the plan.

- Time-Cost projections for completion of the project objectives.
- Ranking the problematic areas.
- Indicating the potential trouble spots.
- Anticipating the scheduled slippage.
- Determining the resources that could be withdrawn, in order to assist other more critical phases.

When the Status Indexes are used with the PERT network system, they provide a clearer picture on both **cost-time status** and **dictated actions.** They can also be used effectively with PERT, LoB, CPM or Milestone reporting techniques, as obtained from the formula:

$$\text{Status Index} = \frac{\text{Progress}}{\text{Scheduled Progress}} * \frac{\text{Budget}}{\text{Actual Expenditures}}$$

8. GERTS-Based Interactive Computer System

This system is analyzing project networks incorporating improvement curve concepts. It was developed in order to cover the gap of the disadvantages and weaknesses of the CPM/PERT techniques, and to incorporate some considerations of real-life operations into a more comprehensive network planning and control system. These considerations and aspects ar

- The ability to modify the duration of the activities, in order to reflect improvement curve trends.
- The storage capacity is limited, and planning evaluation is difficult.

- Managing the level of modeling capabilities is limited and cannot represent the situation accurately.
- Handling and evaluating inherent costs of material personnel, and other shortages.
- There is no allowance for operations that might or might not, be affected by other conditions.

9. Precedence Diagramming Method (PDM)

PDM is an easier and more flexible network approach to modeling large projects than PERT/CPM The distinction is as follows: [Ref. 21:p. 213]

- Additional precedence relationships: Finish to Start (FS), Start to Start (SS), Finish to Finish (FF) and Start to Finish (SF).
- Lead-lag Factors for activities that may be attached to the precedence relationships in order to indicate the beginning or ending of activities.

10. System Dynamic Model

This model was developed to study and implement a revised way for the nature of interconnections between the production functions and the sales activities within the same organization. These activities were examined or operated independently, where it was thought that the latter was the customer of the former. [Ref. 22:p. 15]

11. Daily Automatic Rescheduling Technique (DART)

The objective of this technique is the minimization of in-work flow-time (project duration), and maximization of the utilization of time-consumed production resources within flow-time constraints. Also, this technique was designed to utilize electronic data processing equipment and provide the

electronic data processing equipment and provide the engineering manager some advantages and benefits, over the standard CPM technique. [Ref. 23:p. 185] It's features are:

- Improves production factors that are used for a more effective decision making.
- Level of responsive reactions in production activities increases the production objectives.
- Improves planning and control functions.
- Reduces bureaucracy and overlapping management tasks.

12. Cost/Schedule Control Systems Criteria (C/SCSC)

This system is applied to major production systems and requires the contractor to provide scheduling information on all partial projects. It is not a real-time system, but the contract must be able to provide all the required information to the Government. The major categories are analyzed:

a. Organization

Organization defines the contractual efforts and assigns the responsibility of the contract containing work packages, level of effort, and apportioned work.

b. Planning and Budgeting

Planning and Budgeting examines the plan, schedule, budget, and authorizes required partial responsibility.

c. Accounting

Accounting matches planning and budgeting systems in a "cost performance report". Accumulated costs of work and material are used.

d. Analysis

Analysis compares the planned over the actual costs and also analyzes the resulting variances. The contractor provides the following information:

- Benefit Cost Work Schedule (BCWS).
- Actual Cost Work Performed (ACWP).
- Budget Cost Work Performed (BCWP) Earned Value.
- Budget and Completion (BAC).
- Estimate and Completion (EAC).

e. Revision and Access to Data

This access incorporates changes and develops estimates of final costs.

D. SHIP ACQUISITION CONTRACT ADMINISTRATION MANUAL (SACAM)

The Ship Acquisition Contract Management (SACAM) concerns itself with the use of contract and technical personnel of the office of the Supervisor Shipbuilding, Conversion and Repair (SUPSHIP). Its purpose is to direct and deal with the Naval Sea Systems Command Headquarters (NAVSEA) contracts for the acquisition of:

- Construction and conversion of ships and boats.
- Complex ship overhaul and alterations.
- Refueling nuclear ships.

The Manual describes the activities involved in the placement and administration of ship contracts in planning and scheduling functions before the procurement actions.

The main emphasis is given to procurement process through award of the contract, discussing function responsi-bilities in order to administrator the contract terms.

SACAM concerns itself with the authority contained in Navy Acquisition Regulation Supplement (NARSUP) which permits procuring activities to issue directives, instructions, and other publications to supplement the Federal Acquisition Regulation (FAR), NARSUP and other Navy or DOD instructions.

SACAM also contains the NAVSEA policy and procuremental requirements for compliance by SUPSHIP which is a member of the Contract Administration Services (CAS). SUPSHIP performs all the contract administrative functions and acts as a Procuring Contract Officer (PCO), and for other specified activities under vessel acquisition contracts.

E. THE CONCEPT OF TOTAL QUALITY MANAGEMENT (TQM)

1. Introduction

In her article, "Searching for Excellence in Program Office" [Ref. 23:p. 14] Patricia A. Kelley writes about the applicability between the eight attributes developed in successful companies, from the book "In Search of Excellence" by Thomas J. Peters and Robert H. Waterman, [Ref. 24] and the ten attributes from ten successful defense programs.

2. Attributes

The presentation of these eight attributes of excellence and their brief explanation are as follows:

a. A Bias of Action

- The opinion of managers about the timely decision is that "it is impossible to wait for any perfect knowledge, but it is much better to make a timely decision rather than the right decision" [Ref. 25:p. 20].

- Applying management by walking about, takes time, but it has the great advantage of the human communication.

- Informed exchanges.

- Positive reinforcements.

- Chunking (ad hoc task forces).

- Project teams and project centers.

- Experimentation.

- Making Decisions.

b. Close to the Customer

- Usually the final user determines if the system runs well or determines the product's success and acceptance. The program's success is determined when it "works well when fielded" [Ref. 26:p. 21].

- Project Managers listen to the final user and rely on them for the real needs and requirements, linking them to the producer or contractor. He is trying to satisfy as much as possible these needs, looking also for alternatives when the limit of time and resources does not permit other alternatives.

- Maintain good relations and communication between the Project Managers of both the contractor and the Government.

- Measurement and feedback systems.

- Programs for people (incentives, training, hoopla).

- Quality obsession.

- "Nichemanship".

c. Autonomy and Entrepreneurship

- Encouraging entrepreneurial spirit, stressing the importance of good and open communication, transferring part of decision-making to the lowest level of hierarchy.

- Autonomy far down the line, delegating the authority and responsibility of the daily routine.

- Acute communication.

- Tolerance of failure.

- Keeping focus on limited bureaucratic processes.

d. Productivity Through People

Dealing with people may be the most important job of every Project Manager.

- Treating people as adults and partners with propriety and respect, appreciate their achievements, making positive augments, and offering the happiness of making decisions at their own area.

- Getting quality people to come to the program, providing interesting and challenging jobs.

- Applying Management by walking about.

- Open-door policy of managers.

- Providing responsibility and authority and making a warm atmosphere, working like an extended family.

- Informality.

- Provide information to the ranks.

- Less layering.

- Smallness.

e. Hands-On, Value-Driven

- Paying attention to values and the knowledge that every worker's position has value, building loyalty and "esprit de corps".

- Clearness of position.

- Values stated in qualitative rather than quantitative terms.

- Exertions to motivate people at the lower level of the organization.

- Expectation of excellence.

- Highly visible and attainable leaders.

- Senior managers who set the tone.

- Regular meetings.

- Managers who elicit excitement.

f. Stick to the Knitting

Military Project Managers "stick to the knitting" very well because of specific military spirit and culture. They also tend to be organized in designing, developing and acquiring the required results.

- Staying close to central skills when expanding.

- Caring about the internal growth.

- Keeping acquisition to a minimum.

g. Simple Form, Lean Staff

- Flexibility required.

- Ability to organize frequently and fluidly, to meet the continuous updated needs.

- Authority to squash the line.

- Only few workers at the corporate level.

- Decentralized functions.

- Few career staffers in PMO.

- Bashing the tremendous bureaucracy.

h. Simultaneous Loose-Tight Properties

- Flexibly controlled yet allowing autonomy.
- Entrepreneurship and innovation are expected to contribute authority to workers; as a result they will find innovative solutions to some routine problems.
- Stern disciplinarians.
- Inspire enthusiasm in the staff; getting them excited about the task.
- Quality is evident because of excitement, autonomy, and efficiency.
- Ability to recognize those who disregard directives and rules, having the positive cast for the best interest of the program, concentrating on building, and expanding.
- Simultaneously concentrating internally and externally.

V. PRACTICAL ANALYSIS/IMPLEMENTATION/PROPOSED SOLUTION

A. STAFFING REQUIREMENTS

In an elementary echelon, the Project Manager is working in part in another broader program, and reports to the Program Manager. The sponsor of the program, within DOD, is usually the Navy, especially Chief of Naval Operations staff (CNO). CNO is also the liaison between legislative and military officers. People of CNO are officially responsible to monitor all the operations and stages of the work. Members of the staff of CNO are Development and Program Coordinators.

The Development Coordinator examines the spending of money and every funding issue and ensures the continuity of budgets. The Program Coordinator monitors the progress of the work and makes the routine reports. He is also responsible to the program sponsor. The program chart defines two types of organizational structure:

1. Pure Structure

This is a flexible and self-contained strcuture, by which all functions of jobs are done within the organization. The Project Manager is in charge of dedicated personnel which gives him the advantage of reducing the time required to manage his subordiantes. The weaknesses are higher operating costs and less efficiency because of personnel lost time.

2. Matrix organization

In a Matrix Organization Structure, the Project Manager asks for specific and specialized people, each time he wants to man his team. These specialized people are not dedicated for the specific job and may be lacking in knowledge or ability and have the feeling of being temporarily employed reducing the learning curve or experience doing the same work for an extensive time. There also may be a misunderstanding about the line of authority and for whom they really do work.

B. PERSONNEL STRUCTURE

A Project Manager in the Naval environment is usually a military line officer. This also could be a civilian Government employee with extensive experience. This person is the patron of the project, and the outcome of the project may have direct effect on career.

1. Characteristics

The Project Manager should have the following characteristics [Ref. 27:]:

- Generalist - does not get caught up in detailed jobs and has the broad picture of the project in mind.
- Leader - deals with people in all levels of the daily process.
- Manager - represents the benefits of Government and deals with a variety of people: military, civilian, contractor, subcontractors, etc.
- Persuasive person - reports to his seniors, either military or civilians.

2. Team Personnel

The Project Manager cannot be a person for all seasons and jobs. The Project Manager is escorted by his team of experts, one each for every orientation or division, depending on the environment parameters:

a. Business Financial Manager

The Business Financial Manager is responsible for monitoring the finances, finance relative values, and observer of the Functional Implementation Plan, as well as editor of all key reports.

b. Systems Engineer

The Systems Engineer Manager is responsible for establishing the design of the system during the design phase. He supervises the specification development and modification, as well as support systems design.

c. Logistics Manager

The Logistics Manager makes decisions pertinent to maintenance cycles, and is responsible for predicting unusual situations.

d. Production Manager

Every Production Manager observes the system during the production phase by working in the yard, visiting the facilities and to handling production problems in advance.

e. Coordination Manager

The Coordination Manager ensures the proper documentation for the current changes of specification.

f. Contract Officer

Depending on the organizational structure, the Contract Manager may or may not report directly to the Project Manager. He is responsible for the following:

- Awarding the contract.
- Monitoring the contract during various phases.
- Managing the legal actions during operations.
- Generating the design phase which is done for the acquisition strategy and the acquisition plan.
- Tasking the contractor for the performance of the work.

g. Deputy Project Manager

This position is optional, but useful for the continuity of the project. He is responsible for daily business and could be a military or civilian person.

3. *External Organization*

In the external organization of the program there exist military agencies that could support any project. The Project Manager is depended upon to ask for external support. This is a great advantage before the start of the project. The Project Manager must have a direct contact with these agencies, by visiting the locations and deciding how they could be serviceable. The main disadvantage of this process is workload and paper work requirement. By using Government Laboratories and Centers, the following advantages may be realized:

- Lower costs.
- Experience in repetitious military business jobs.
- Complete approach to databases.
- Data for learning curves.
- Assurance that material and labor meet military specifications before going out on a contract bid.
- Support in source selection and technical merit, including quality.
- Support in establishing Test and Evaluation Master Plan for further development (TEMP).

C. A FULLY COMPUTERIZED SYSTEM

While living in the information era and monitoring the construction in detail, it is essential to a Project Manager to have an up-to-date comparison between the theoretical and the practical (existing contract requirements). This requires supervisors to keep abreast of all phases and procedures of construction; to make adjustments whenever a problem arises and to follow the predefined goals and be ready to report to the staff.

All these regulations are present in various degrees in all control systems and generally reflect the non-routine or uncertain nature of the project environment. The Project Manager depends heavily on the control system and may frequently be involved in determining scope and objectives. He must also determine alternatives in order to allow any optimal resource utilization. The level of effectiveness

determines whether the Project Manager will control the project or the project will control him.

Usually, daily routine information is interrelated and can be considered as a Total Management System (TMS) [Ref. 28:p. 19]. At almost every turn there is a conflict in accurately monitoring information between working personnel, to wit:

- The overlap of job responsibility or authority.
- The primary and secondary character of the project priorities.
- The type of control or management system.
- The flow of information.
- The type of the computer-based Management Information System (MIS).

Each TMS should be designed to support all the operating activities of the construction and each element should also be in balance with all other related elements within the system.

The architecture and use of an MIS is not a panacea. It is just a good way to assist the functional managers. A link between the MIS of a Project Management team and the contractor is needed for better communication and data interchangeability. This brings up the question of who is right and who is responsible for making decisions regarding changes of the MIS, during the construction and after implementation.

The introduction and use of a computer-based control system is not an easy process. Quite often a system will fail

not only because of technical deficiencies, but also because of organizational and behavioral problems. Examples are as follows: [Ref. 29]

- The organization's resistance to new systems.
- The unbalanced management system.
- The resistance to changes in the authority flow.
- The general work responsibilities.

D. SOFTWARE PACKAGES

It is essential for the Project Manager and all involved personnel to carry out the project effectively. In order to keep and retrieve the information required, the quality of the software is important. The expected capabilities would contain the following:

- Network plans.
- Financial and budgetary reports.
- Progress reports.
- Special problem reports.
- Main project plan and changes.
- Results of meetings.

In the free market there are many software packages available, which can be utilized for the construction of an MIS. The best package choice depends on our purpose or goals and determining requirements may be a difficult task. Usually these "canned" programs are very broad and general, so that they appeal to a wide range of customers.

Some of the most important middle level and available software packages in the market (they exceed one hundred and usually work with LOTUS, Graphics, or special menus [Ref. 30:p. 180] are listed below:

Product	Company
a. InstaPlan (1.03B)	InstaPlan Corp.
b. MicroTrak (1.6)	SoftTrak Systems
c. Pertmaster Advance (2.0)	Projectronics
d. PMS-II (8.1)	North American MICA
e. Pro Path Plus 1.0 Level (26)	SoftCorp
f. SuperProject Expert (1.0)	Computer Associates Int
g. TimeLine (3.0)	Symantec
h. Timepiece (1.3)	Communication Dynamics
i. Topdown Project Planner (1.01)	Ajida Technologies
j. ViewPoint (3.0)	Computer Aided Mgmt.
k. Harvard Project Manager III	Software Publisher
l. Microsoft Project (4.0)	Microsoft

The major considerations of the above software packages are that they handle resource planning of long-range group efforts with efficiency. They require only basic information, such as a beginning and ending point including some parametric factors. They can then automatically set the plan, which is flexible, recalculating whenever input changes occur, and reschedule any necessary change while defining task inter-

relationships. They also project future estimations under different scenarios. In other words, they fit available resources and time to project needs.

In the early 1960's, the Naval Systems Sea Command (NAVSEA) in Washington, DC was faced with the need for a management control framework, to be used by a ship's force during an overhaul [Ref. 31:p. 10]. Later, NAVSEA sought to solve this problem by hiring a private automated data processing company; but the program cost per ship exceeded one half million dollars. The contract was later terminated.

Instead, the Navy created an organization designated Planning and Engineering for Repairs and Alterations for Aircraft Carriers (PERA CV). This organization develops computerized management control systems to be used during overhauls. The PERA CV system was modified and used by other types of Navy Ships overhaul projects during the early 1970's. [Ref. 32:p. 11]. In 1976, the Fleet SFOMS program was established for scheduling and controlling the ship's manpowere, based upon usage during an overhaul.

NAVSEA personnel, working towards computer automation, determined that the best way to build an MIS is on a personal Computer (PC) network. This PC configuration had the great advantage of interconnectability between different types of PC hardware. The advantages include:

- Friendliness to the final user.
- Ease of to training personnel.

- Expandability.
- Structured database.
- Availability of software for communication, link, etc.
- Low cost.
- Personnel may already have PC experience.
- Flexibility in changes.

For these reasons, NAVSEA decided on the procurement of a special MIS for use within the Navy. The procurement is based on the **DATABASE 3 PLUS** software.

E. PERFORMANCE MEASUREMENT AND EVALUATION

The performance of a Ship Construction is perhaps one of the most difficult parameters to control. This is mainly due to the difficulty of measuring performance and its interaction with cost and time. A successful means of controlling and monitoring the progress and cost could be done through the use of some accepted techniques previously mentioned in Chapter V.

Management control should focus on positive performance and the measurement must be done within this framework. This approach has an explicit preference for the optimum utilization of the available resources. Any positive contribution of personnel will help reach the desired goals. There are going to be direct and consistent connections for managers' actions that will help reach the organization goals.

In order to maximize the goals, appropriate measures of performance are needed.

Searching for optimal policies under existing conditions, Project Managers should be encouraged to actively intervene in the job process under the assumption that the existing conditions can be changed. On the one hand, the easy part of measurements are the financial and cost accounting measures that can be compared with programmed or standard cost. On the other hand, variables such as measuring the performance, concepts of quality, lead times, flexible flow lines, long term efficiency, automation, managerial expenses, effective use of information, personnel attitudes and managerial commitment are difficult to measure.

Comparing Project Management and Small Businesses, we observe many common aspects and concepts. The main and principal idea is that of controlling inadequacies and their relative factors. In fact, the Small Business Administration (SBA) estimates suggest that more than two-thirds of new businesses are unable to survive their first year. In an earlier 1954 SBA study, the causes of failure small businesses include:

- Inadequate records.
- Inaccurate cost information.
- Lack of inventory control.
- Failure to budget expenditures.
- Excessive operating costs.

- Little or no internal checks and controls.
- Little or no tax planning.
- Faulty purchasing practices.
- Faulty sales and credit policies.
- Lack of sound and effective credit policies.
- Insufficient capital.
- Excessive investment in plant and equipment.

F. PROFESSIONAL REQUIREMENTS

In order to satisfy increasing program demands, the following list of elements in knowledge and abilities are required as a minimum level of prerequisites to perform the functions and meet the mission and goals:

- Knowledge of the basic techniques, processes and procedures established within the program for managing designated projects, and the ability and willingness to use them.
- Knowledge of contractual and funding rules, regulations, relationships and administrative processes involved in developing and procuring the material of the signed contract.
- Knowledge of the objectives of the project and its relation to the total program, and the consequential knowledge of environmental conditions, uses, required characteristics and features, human factors, and similar considerations.
- Knowledge of the overall development cycle processes, and the subsequent testing and evaluation processes involved in acceptance of the end product.
- Knowledge of the scientific and engineering fields involved and the type and nature of work being pursued in advancing the state-of-the-art.
- Ability to plan and organize the work to accomplish a variety of concurrent activities performed in a variety

of organizations (in-house, contractors, task forces, study groups, etc.).

- Ability to analyze situations, identify problems, probe causes, and suggest courses of action for technical and functional specialists to pursue.

- Ability to accomplish work effectively through others, to maintain harmonious relationships among all parties, to achieve appropriate and timely support, and to reconcile divergent viewpoints.

- Ability to gauge the effort required to the situation at hand, to be selective in what to do and how to proceed, and to recognize the resulting impact in terms of cost, schedule, and risks involved, and trade-offs necessary.

- Ability to communicate effectively in writing and in person-to-person contacts.

- Ability to escape from unusual cases and resolve unusual or unpredictable situations, within the existing margins of responsibility and authority, without postponing or transferring the problem to the higher level.

G. AUTHORITY

The level and kind of authority given a Project Manager is essential for the work structure. Clear and explicitly defined authority provides higher effectiveness. Indications are that authority is not merely delegated from superior to subordinate. On the other hand, a certain degree of personal freedom is required in the project environment and much more for professional people. These two concepts are both contradictory and complementary, and continually challenge the Project Manager. After all, the Project Manager has to:

- Cross the functional lines to bring together his activities that are required to accomplish NCPM objectives.

- Project the force of his leadership to departments and organizations that are not in his hierarchial structure and whose personnel, therefore, owe their fidelity to a different manager.

- Use all available power in order to meet the completion of the project on time, within the cost and the performance requirements.

The bottom line remains on the dependence of the personality of the Project Manager. He must have **de facto** as well as **de jure** authority. Dr Merrit Williamson states that, "A person has authority only if his orders and directives are accepted by those who work for him".

VI. RESULTS/CONCLUSION/RECOMMENDATIONS

A. RESULTS

In the shipbuilding business environment, we face the following constraints:

- Complex and expensive weapon systems.
- Long construction periods.
- Highly competitive environment.
- Future workload uncertainty.
- Fiscal uncertainty.

During construction, unpredictable deficiencies occur. Some reasons for this are:

- Underestimated schedules and cost.
- Changes in requirements and configuration, and especially requirements for the most sophisticated systems available, irrespective of cost (because of rapid pace of technological improvements and change of threat environment).
- Lack of incentives to produce program costs.
- Lack of professionals on a continuous basis.

B. CONCLUSION

The most important points for project managers to learn from this thesis are summarized as follows:

- Establish challenging attainable goals.
- Define organizational span.
- Carefully select subordinates.
- Delegate authority and reward superior performance.

- Emphasize reinforcement by accepting responsibility, supporting limited autonomy, and encouraging decision making participation.

C. SUMMARY AND RECOMMENDATIONS

This thesis has attempted to provide the duties and responsibilities of how to control a challenging level of work and extensively presented all the involved concepts and factors in business as well as the matters of the Project Manager in the arena of a Naval Construction. In order to prioritize the dedicated concepts and factors, prototype work was not presented. The following recommendations are provided for consideration to the Naval Construction Project Management. The Project Manager compromises and blends them to achieve the total desired result to effective and efficient Contract Management. The key words that a Project Manager should have in mind are:

- Manager's primary functions (Planning, Organizing, Staffing, Directing, and Controlling).
- Educational and Skills improvement.
- Introduction and incorporation of Total Quality Management.
- Select and use the proper Project Management techniques, including the suitable software packages.
- Resolve the inherent personnel selection and communication.
- Connect the project with the phases of the acquisition schedule in clear command channels.
- Implement the required steps and factors to promote productivity and reduce the final cost.

The following statement of the former Secretary of Defense, **Robert MacNamara,** illustrates the important role of the Project (Program) Manager in the Military environment [Ref. 33:p.]

> "I want to look to a point of central control and information in the form of a Program manager for each major weapon system. He shall be rewarded in his career for prompt and analytical disclosure of his problems as well as for his successes. This is a key position in our military departments, demanding the best managerial talents on which I want to place full reliance for our future weapons inventories".

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